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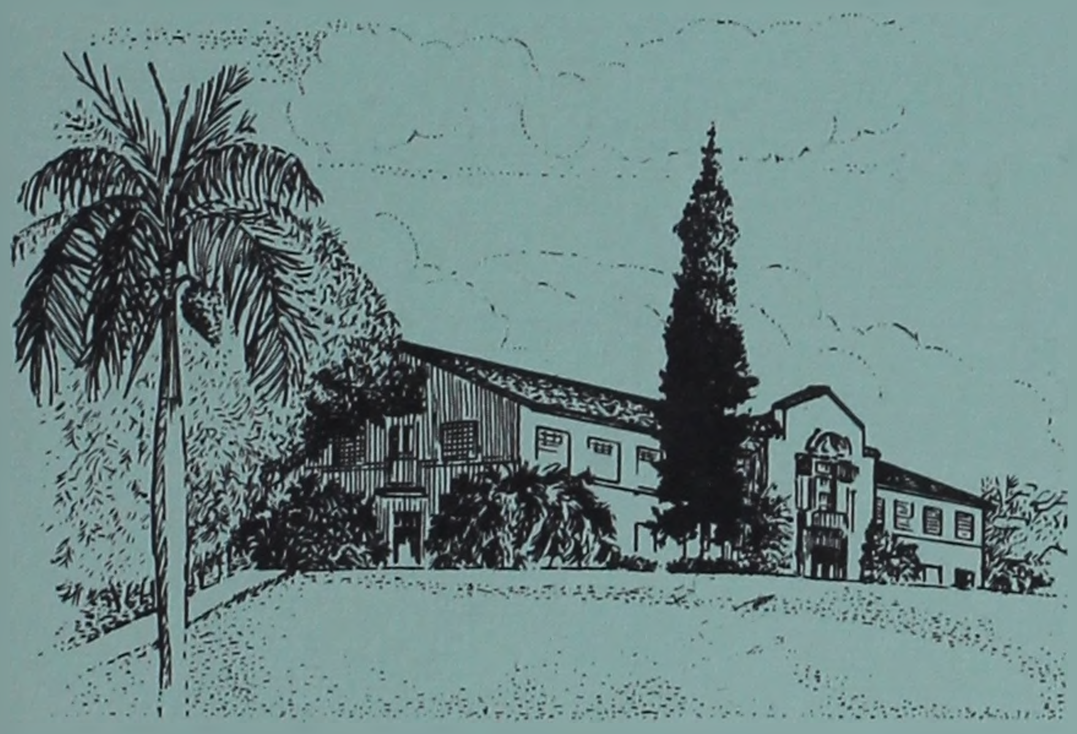
THE EFFECT OF INCISING ON DRYING, TREATABILITY, AND BENDING STRENGTH OF POSTS

BY

M. CHUDNOFF AND E. GOYTIA



INSTITUTE OF TROPICAL FORESTRY

RIO PIEDRAS, PUERTO RICO

FOREST SERVICE

U.S. DEPARTMENT OF AGRICULTURE

RESUMEN

Los terrenos forestales de Puerto Rico contienen cierta cantidad de por lo menos 50 especies de árboles disponibles para postes de cercas. Debido a que generalmente están distribuídas en rodales mixtos, la segregación por especies o grupos de tratabilidad antes de la aplicación de preservativos no es práctica. Se hicieron pruebas de las incisiones a ras de tierra combinadas con un programa universal de baño caliente y frío como un método práctico para tratar grupos de especies mixtas.

Se da una descripción breve de una máquina comercialmente factible para hacer incisiones en los postes. Esta máquina fué usada para preparar material de prueba para determinar el efecto de las incisiones en: 1) tiempo de secado al aire, 2) tratabilidad y 3) resistencia a la flexión de postes de diámetro pequeño.

Las diferencias en el tiempo de secado al aire para alcanzar un contenido de humedad de 25 por ciento para postes con y sin incisiones no fueron significativas. Se hizo una comparación de retención y penetración de aceites preservativos, aplicados por un proceso termal de 2 horas - 2 horas, de postes cuyas incisiones fueron hechas cuando estaban verdes, después de secados al aire y de testigos sin incisiones. Solamente las diferencias entre los grupos con y sin incisiones fueron significativas. De 20 especies que se probaron en el grupo con incisiones, 4 obtuvieron tratamientos marginales comparadas con 17 especies en el grupo sin incisiones que obtuvieron tratamientos inaceptables. Las pruebas de vigas voladizas demostraron una reducción de 15 a 25 por ciento en la resistencia a la flexión debido a las incisiones. Esto se considera aceptable comparado con los beneficios obtenidos por la concentración del preservativo en el vulnerable nivel de tierra debido a las incisiones.

THE EFFECT OF INCISING ON DRYING, TREATABILITY, AND BENDING STRENGTH OF POSTS

By

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SUMMARY

The forest lands of Puerto Rico contain at least 50 species available in some quantity for fence posts. Because they are generally scattered in mixed stands, segregation according to species or treatability groups prior to the application of wood preservatives is not practical. Groundline incising together with a single universal hot-and-cold bath schedule was tested as a practical method of treating batches of mixed species.

A brief description of a commercially feasible post incising machine is given. This machine was used to prepare test material to determine the effect of incising on: 1) air drying time, 2) treatability, and 3) bending strength of small diameter posts.

Differences in air drying time to reach a moisture content of 25 percent for incised and non-incised posts were not significant. A comparison of retention and penetration of preserving oils, applied by a 2 hour - 2 hour thermal process, was made of posts incised while green, incised after air drying, and non-incised controls. Only differences between the incised and non-incised groups were significant. Four species out of 20 tested in the incised group had marginal treatments as compared to 17 species in the non-incised group that had non-acceptable treatments. Cantilever beam tests show a 15 to 25 percent reduction in bending strength due to incising. This is considered tolerable compared to benefits gained by the preservative concentration at the vulnerable groundline due to incising.

1/ In cooperation with the University of Puerto Rico

INTRODUCTION

The forest lands of Puerto Rico contain at least 50 species that are available in some quantity for fence posts and small poles. Except for a few mangrove areas and a limited acreage of plantation-grown exotics, these trees are scattered in mixed stands with little or no concentration of any one species. Harvesting usually must be carried out on difficult terrain and would be costly if restricted to those species most receptive to a preservation treatment.

Commercial wood preservation plants are generally concerned with the treatment of a few selected species. In most cases there is no difficulty in establishing schedules that will result in the desired chemical retention and penetration. In Puerto Rico, cuttings in natural stands may yield as many as 20 to 30 species per acre. It would not be practical to keep this material segregated by species or treatability groups from time of felling through to the application of preservatives by various schedules. A preferred choice would be the use of a single schedule for non-sorted stock with perhaps a greater toleration of some under-and-over treatment.

The thermal or hot-and-cold bath method using an oil-type preservative appears suitable for fence post treatment in Puerto Rico. Consumer acceptance and enlarged markets could subsequently lead to the establishment of a more efficient pressure-vacuum system.

Studies have been made at the Institute of Tropical Forestry to determine thermal schedules most suitable for some selected species (7). To obtain the desired retentions, time in the baths varied considerably, e.g. posts were submerged in the hot bath from 2 to 15 hours followed by cold baths that ranged from 1 to 120 hours. These schedules were used to obtain treated material for serviceability tests. They would not be applicable in a commercial operation.

The use of a single short schedule for mixed species having a wide range of treatability may be more feasible, but should result in a large divergence in chemical retention and penetration. Systems of incising for railroad ties and utility poles have been developed to improve the preservation of refractory woods. Its application to fence posts has been limited (3, 10, 13). Results of the Forest Products Laboratory tests (3) on 4 species show that incising may increase cold soaking absorptions by 30 - 40 percent. Results presented by the others are not as obvious.

This report describes briefly a new post incising machine design. Also presented are the effect of incising on air drying time, the absorption of preserving oils, and the bending strength of fence posts.

POST INCISING MACHINE

Commercial incising machines are readily available for processing sawn timbers and utility poles (1). An experimental combination post peeling and incising machine was developed at the Oregon State University (9), but would not have been suitable for high density woods or very irregular stems. The few posts that have been incised prior to this test have been set out in several test plots (3, 10, 13) and these have been prepared manually using an incising hammer (11).

The post incising machine designed at the Institute of Tropical Forestry has been described in detail (5). This machine can penetrate woods having a wide range of density and accept crooked stems, but is limited to a maximum diameter of 5 inches. Briefly it consists of three major components: 1) top and bottom incising drums, 2) a pressure cylinder, and 3) an electric drive motor with speed reduction (figure 1).

Each drum mounts 5 rows of staggered "oyster-knife" type teeth 3/4 inch long. The selected incising pattern gives a distance of one-half inch between tooth rows and about 2 inches within rows. The tooth-mounted center section of the drum is machined to a 2 1/2-inch radius to permit full penetration of all 5 rows of teeth into a 5-inch diameter post.

A two-way air-operated piston raises and lowers the bottom incising drum. Piston diameter is 8 inches. Thus an air pressure of 40 p.s.i. results in a piston load of 2000 pounds. The machine is designed for a maximum working load of 6000 pounds which permits simultaneous imbedding of 5 teeth into most dense woods.

A 1-horse power motor drives the upper incising drum. Speed is reduced by gears and a sprocket and chain drive to obtain a rotation of 10 turns per minute. At this speed, 1000 posts can be incised over an 18-inch groundline zone per 8-hour shift. Two or three passes through the machine will cover the post circumference with incisions.

This machine was used to incise all posts under test in this study and is now installed at a preservation plant for evaluation under production conditions.

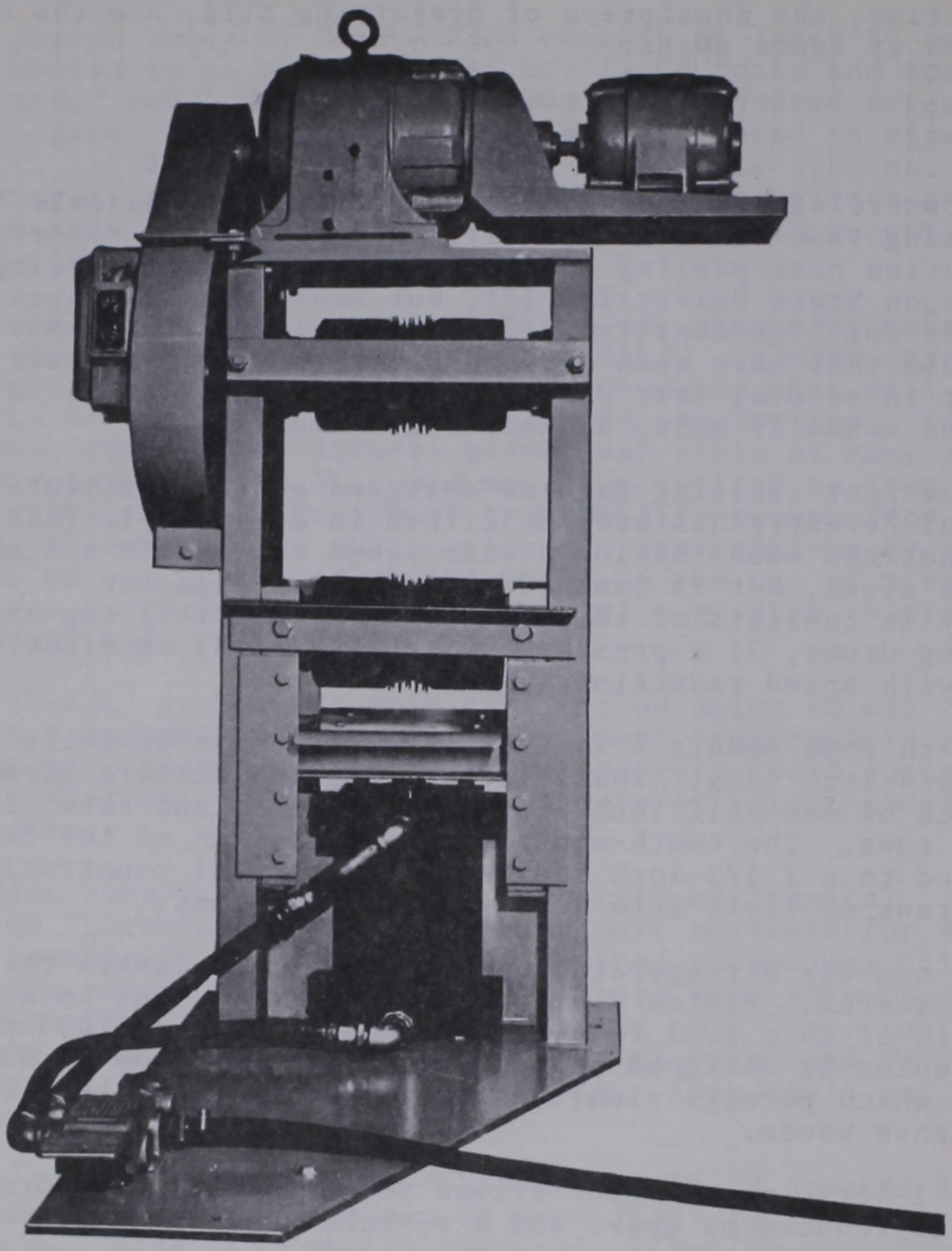

Figure 1.--General view of Institute of Tropical Forestry incising machine showing drive motor, top and bottom incising drums, and loading piston with foot-operated air valve.

TEST MATERIAL

Thirty 7-foot posts representing each of 20 species were prepared for this study. Top diameter ranged from 2 to 4 inches. Most of the species selected had a wide range of treatability as determined by previous cold soaking studies (7). Six of the species are plantation-grown exotics, i.e. cadam, casuarina, eucalipto, pino, caoba, and teca. The woods selected are as follows in order of increasing basic specific gravity (based on oven-dry weight and green volume):

Puerto Rican Common Name	Scientific Name	Basic Specific Gravity
Pino	Pinus caribaea Morelet	.31
Cadam	Anthocephalus cadamba (Roxb.) Miq.	.39
Eucalipto	Eucalyptus robusta J.E. Smith	.40
Teca	Tectona grandis L.F.	.52
Caoba	Swietenia macrophylla King	.54
María	Calophyllum brasiliense Camb.	.55
Cacao motillo	Sloanea berteriana Choisy	.55
Mangle blanco	Laguncularia racemosa (L.) Gaertn. F.	.60
Roble blanco	Tabebuia heterophylla (D.C.) Britton	.60
Moca	Andira inermis (W.Wright) H.B.K.	.62
Guaba	Inga vera Willd.	.63
Rabo de ratón	Casearia arborea (L.C.Rich.) Urban	.63
Hoja menuda	Myrcia splendens (Sw.) DC.	.64
Guamá	Inga laurina (Sw.) Willd.	.66
Pomarrosa	Eugenia jambos L.	.68
Casuarina	Casuarina equisetifolia L.	.70
Caimitillo	Micropholis chrysophylloides Pierre	.73
Péndula	Citharexylum fruticosum L.	.74
Mangle prieto	Avicennia nitida Jacq.	.76
Uvilla	Coccoloba diversifolia Jacq.	.84

Posts from two of the species (cadam and pino) were already on hand in an air-dried condition. All others were freshly felled. Eight of the 30 posts representing each species were cross-cut into 3-foot lengths. Twenty full-length posts were set aside for air drying, subsequent treatment with or without incising, and then installation in a serviceability test plot.

The 3-foot lengths were used to measure the effect of incising on drying time. They were also used to determine the effect of incising, in either the green or dry condition, on retention or penetration of the preserving oil, i.e. 5 percent pentachlorophenol dissolved in diesel oil.

To determine the effect of incising on the bending strength of air-dried posts, 10 pairs of pino, 10 pairs of casuarina, and 10 pairs of mixed hardwoods were also available for loading as cantilever beams.

Immediately after bark removal and prior to air drying, all posts were given a dip treatment using a water emulsion of sodium pentachlorophenate, borax, and benzene hexachloride. This is to give temporary protection against insect and fungus attack during seasoning.

EFFECT OF INCISING ON AIR DRYING TIME

Three 7-foot posts from each of the 18 species available in the green condition were used in this air drying study. Each post was cross-cut to give two 3-foot lengths. One of each pair of sticks was incised full length. This gave 6 sticks per species (3 incised and 3 non-incised controls). Trim pieces were used to determine the initial green moisture content. All sticks were then weighed and piled for air drying. Subsequent weighings were then made at frequent intervals and current moisture contents were calculated. For comparative purposes, the air drying process was considered completed when a moisture content of 25 percent was reached.

Drying curves of incised and non-incised eucalipto and guamá sticks are shown in figure 2. The eucalipto, with an initial green moisture content of 115 percent, required 54 days to dry the incised posts to a moisture content of 25 percent. The non-incised controls required 42 days. In comparison, guamá had an initial moisture content of 56 percent and yet required 58 and 76 days respectively for the incised and non-incised posts to reach the desired moisture content. Similar drying curves were plotted for the other species. Results for all species are given in table 1. Average drying time for the incised sticks is 36 days. The non-incised controls average 34 days. These differences in drying time to reach a moisture content of 25 percent are not significant.

Our results are similar to those found by Harkom (12). He observed that incising of beech, birch, or maple railroad ties before air seasoning had no appreciable effect on rate of drying or final moisture content as compared to non-incised controls.

EFFECT OF INCISING ON ABSORPTION AND PENETRATION OF PRESERVING OILS

Fifteen 3-foot long matched sticks from each of the 20 species were available for this phase of the study. Five of

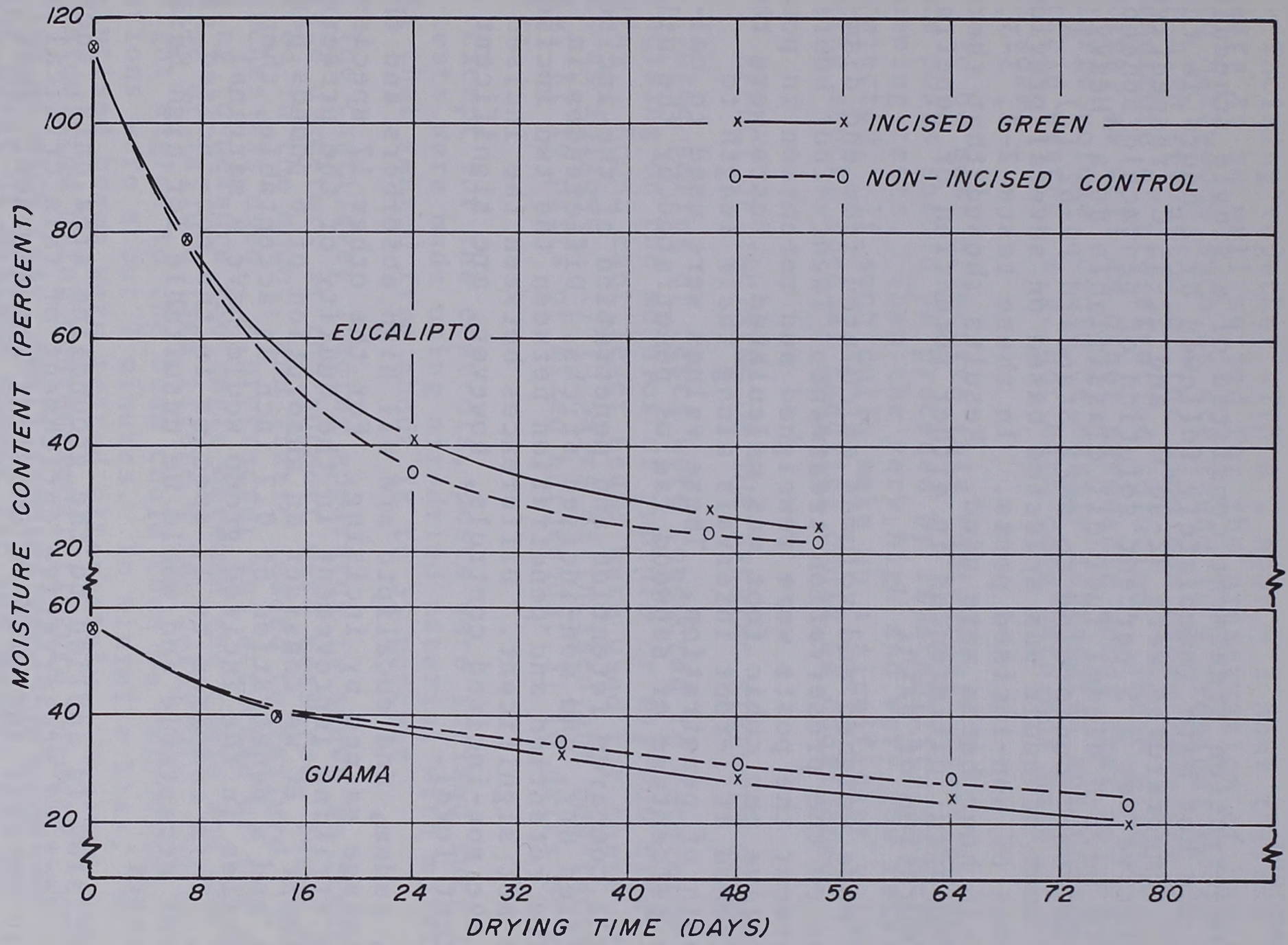

Figure 2.--Air drying curves of incised and non-incised posts representing a fast drying species with a high initial green moisture content (eucalipto) and a slow drying species with a relatively low initial moisture content (guamá).

the 15 were incised while green prior to air drying, 5 were incised after air drying, and 5 controls that were dried but not incised. All sticks were end-coated with a resorcinol formaldehyde adhesive to limit preservative penetration to the side grain. Moisture content at time of treatment ranged from 15 to 25 percent.

The preservation treatment consisted of a single schedule... 2 hours in the hot bath immediately followed by 2 hours in the cold bath. Temperatures were 92-96°C. and 32-35°C. respectively. The preservative was a 5 percent solution of pentachlorophenol dissolved in No.2-D diesel fuel oil classifiable as a "Heavy Petroleum Solvent" conforming to AWPA Standard P9-62 (2). A 2 hour - 2 hour schedule was selected based on several previous trial batches of non-incised posts. In these tests 2-2, 3-3, 4-4, and 4-16 hour baths were used. Results showed that there were no meaningful differences in either retention or penetration with duration of bath.

Posts were weighed and volumes calculated from end diameters prior to the preservation treatment. Twenty-four hours after treatment the posts were reweighed and retention in pounds of preservative per cubic foot was calculated. Posts were then cross-sectioned at 1-foot intervals along their length to measure depth of penetration. These values were used to calculate the percentage of sapwood radius penetrated by the oil.

Table 2 compares retention and penetration of the incised green, incised dry, and non-incised sticks. Differences in preservative retention and penetration between the two incised groups are not significant. Differences between the incised posts and the non-incised controls, however, are significant at the 5 percent level.

Pino, cadam, and eucalipto are all high absorbers and there is no advantage gained by incising. For the other 17 species there is a striking improvement in the quality of the preservation treatment. If we consider an absorption of 6 pounds per cubic foot and a penetration of 0.7 inch as acceptable, then about 4 species in the incised group would have a marginal treatment. This compares to 17 species in the non-incised group that are not acceptable and would be unsuitable for high hazard ground contact.

If incising is applied to the groundline area only, there would be a decided preservative enrichment of this critical zone with little overall increase in chemical consumption. Post tops, except for end grain areas, may be vulnerable to insect and fungi attack. Recent inspections of test plots do not support this (6). Posts treated by cold soaking in pentachlorophenol had about the same level of preservative retention and

penetration as our non-incised posts. About 1000 of these posts were installed in 1959. Less than one-third are serviceable after 8 years, yet there were no failures whatsoever in the tops. All of the removals were due to decay and/or insect attack at the groundline.

Incising together with a 2 hour - 2 hour thermal schedule appears to be well suited for the preservation of batches of mixed hardwoods such as are found in a Tropical Moist Forest. The very high retention of the pino and cadam requires a costly expenditure of preservative solution. These plantation-grown species, as well as other permeable woods that may be available in large volume, could be easily segregated and treated by a more suitable system, e.g. hot bath-cold bath-hot bath or by a short cold soak.

To be most effective this "universal" treating program for fence posts should be preceded by treatability or permeability screening tests. Then the very high and very low retainers could be rejected. If such culls make up a significant volume of the growing stock, special handling could be considered.

EFFECT OF INCISING ON THE BENDING STRENGTH OF POSTS

Three series of tests were conducted to determine the effect of incising on the modulus of rupture or maximum fiber stress in bending. Round cantilever beams were used for these strength tests as follows: 1) 10 pairs of incised and non-incised pino posts, 2) 16 pairs of mixed hardwoods, 3) 10 pairs of casuarina posts.

Except for the controls, posts were incised full length. All tests were made using air-dried material with moisture contents that ranged from about 18 to 35 percent.

The cantilever loading apparatus is shown in figure 3. Average diameters at the support were measured, beams were secured in the mount, and static loaded to failure. A span of 50 inches was used. A protractor was attached at the point of loading to measure the angle between the cable and the beam axis at time of failure (see figure 4 for details). The maximum load at right angles to the beam could then be calculated. Load durations were about 2 minutes. To minimize bias, incised and non-incised beams were tested alternately. Maximum fiber stress was calculated using conventional flexure formula. At the completion of each test, small samples were cut from the zone close to the point of maximum moment (at the mount) for the determination of moisture content and specific gravity based on oven-dry weight and volume. All failures were at the mount and were either simple or splintering tension types (see figure 5).

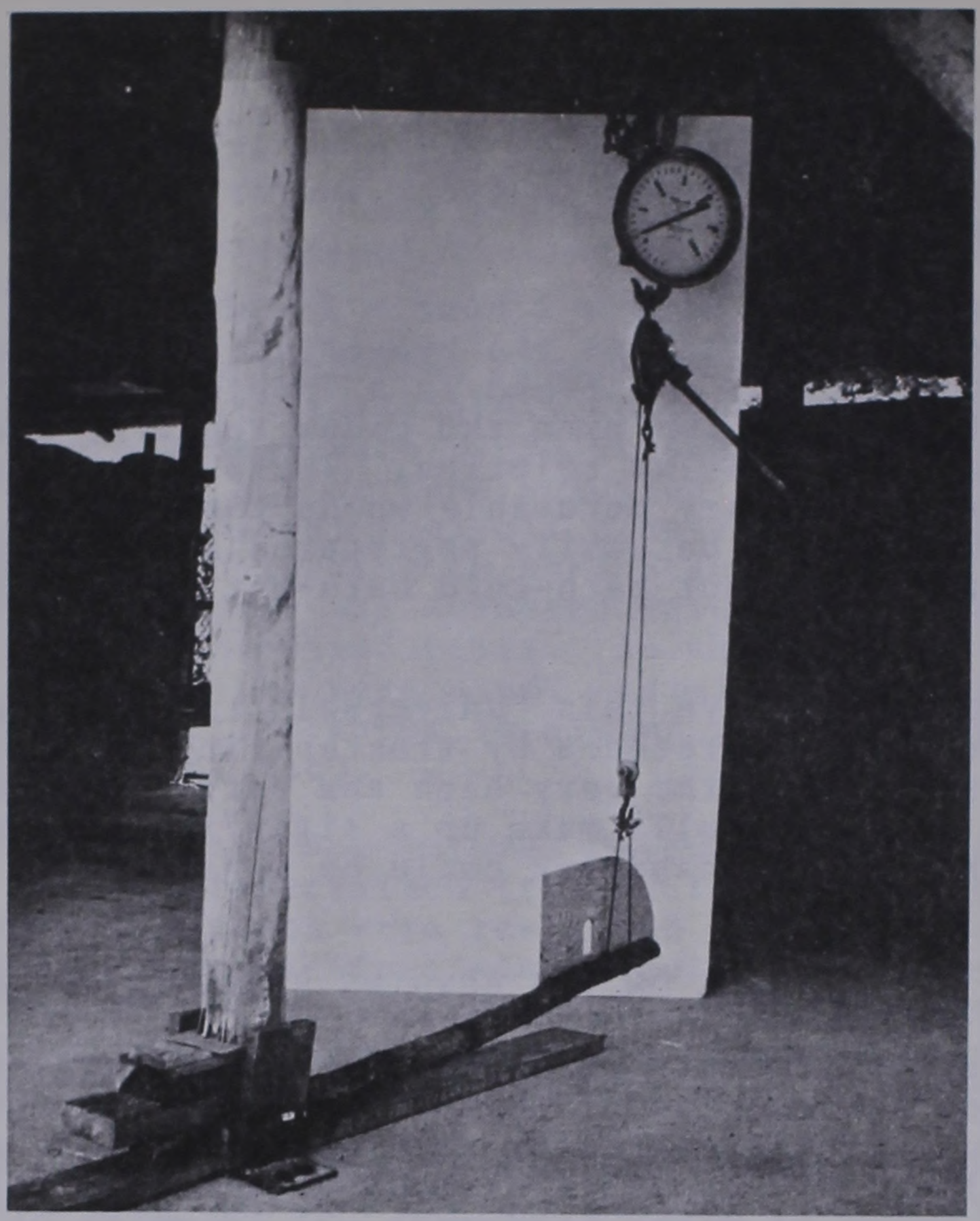

Figure 3.--Cantilever beam testing set-up showing cable stressing of post, loading winch, and dynamometer.

Results of these beam tests are given in tables 3,4, and 5. A comparison of the modulus of rupture of incised and non-incised controls of pino are given in table 3. Specific gravity and moisture content averages for both groups are almost identical and no adjustments for these variables are needed. The incised posts have an average modulus of rupture that is about 75 percent of the controls. Some of this strength loss may be due to the slits made by the incising teeth. A part of this reduction may also be due to crushing by the incising drums. The pino posts were incised using an air line pressure of 30 p.s.i. or a piston load of 1500 pounds. This would exceed the proportional limit in compression perpendicular to the grain. Such loss in strength could be reduced somewhat by continuously adjusting the air pressure so that the incising teeth just penetrate to their full length. This would be awkward and impractical in a production operation.

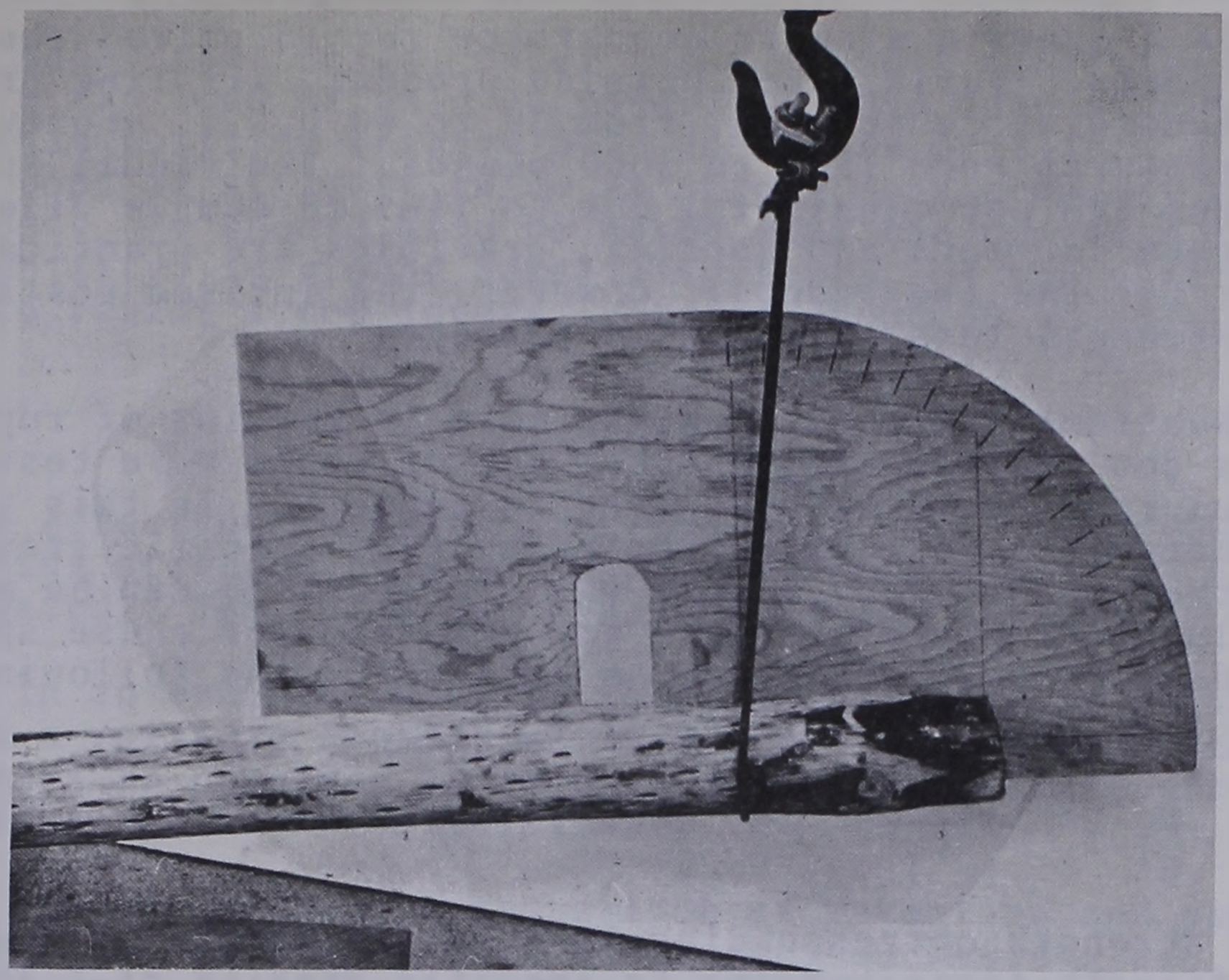

Figure4.--Detail of protractor attachment and method of reading loading angle for the calculation of the force at right angles to the post axis.

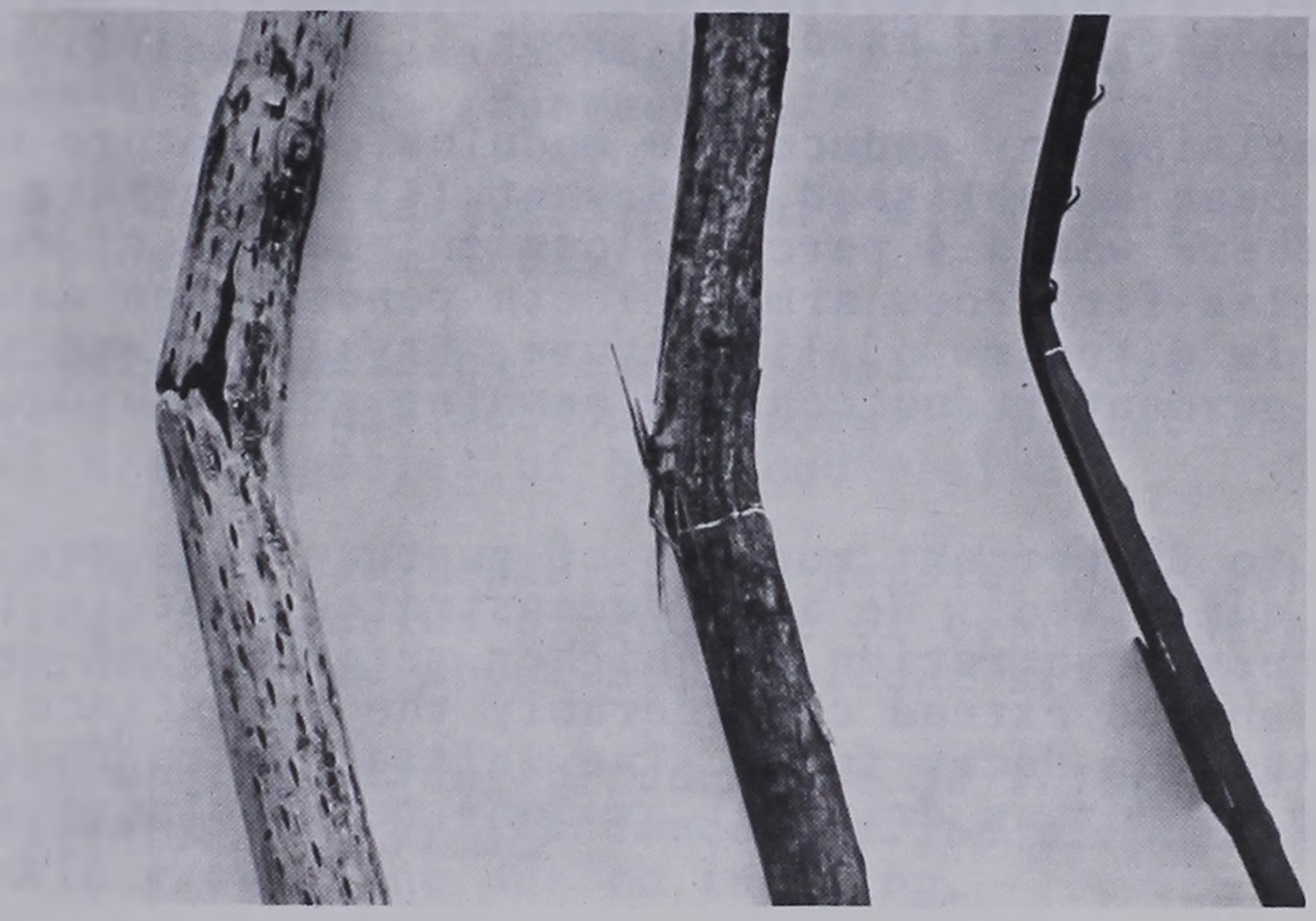

Figure 5.--Failures at the support (maximum moment). Incising patterns and a typical simple tension failure is shown by the post on the left; center post has a splintering tension failure. The metal post shows failure by buckling.

Table 4 shows a similar comparison for 16 paired species of hardwood posts. During the incising process, air line pressures varied, according to species, from 30 to 60 p.s.i. Equivalent piston pressures were 1500 to 3000 pounds. Individual species comparisons are not meaningful due to limited sample size. Average moisture contents and specific gravities are practically identical for the two groups. However, the incised posts have a bending strength loss of about 14 percent.

To substantiate this apparent loss in modulus of rupture of hardwoods due to incising, another set of posts were tested using only casuarina. Results are given in table 5. In this test series there is some discrepancy in average specific gravity between the two groups. A more valid comparison can be made if the modulus of rupture averages are adjusted for these specific gravity differences. This can be done using the following equation (8):

$$\frac{S}{S^1} = \frac{(g)^n}{(g^1)}$$ where:

S is the strength corresponding to specific gravity g and S^1 is the strength corresponding to specific gravity g^1. The value for exponent n is 1.50 for the modulus of rupture strength property.

The adjusted modulus of rupture of the non-incised control is 16,700 p.s.i. for an average specific gravity of 0.88. The incised posts compared to this corrected value have an average strength loss of 15 percent. Almost identical to the results obtained with the mixed hardwood group.

That incising may reduce the modulus of rupture of wood members has been established by Bryant (4) and others. Bryant found that there was a 4 percent loss in modulus of rupture of incised Douglas-fir cross arms. Tooth penetration was only 3/16 inch. In a review of literature, Bryant refers to reports of 10 to 20 percent reductions in bending strength due to incising.

The 15 to 25 percent modulus of rupture loss may be of concern if not qualified. We have demonstrated that incising results in deeper penetration and higher retention of preserving oils. This should extend considerably the resistance of the posts to attack by decay fungi. The initial strength loss caused by incising is not as critical as long term vulnerability to decay.

An incised post having properties similar to the low strength pino would require a groundline diameter of 3 inches to resist a lateral top load of 170 pounds over a 50-inch span. A 2-inch diameter groundline would be required by the average hardwood post tested to resist a 135-pound load. "U" type

2.5 mm. gage steel posts, under the same test conditions, would require a top load of only 70 pounds to bend into a non-serviceable position (figure 5). Thus a 2- or 3-inch diameter incised post is at least twice as strong as a commonly accepted steel post. It should also be noted that the criteria for serviceability, in ground durability tests, is the ability of a post to resist a top lateral load of about 30 pounds.

CONCLUSIONS

The effect of incising on air drying time, treatability, and bending strength of small diameter fence posts has been investigated. The following conclusions can be made:

1. In an evaluation of 18 species, average air drying time to reach a moisture content of 25 percent was 36 days for incised posts as compared to 34 days for non-incised controls. This difference is not significant.

2. For 20 species, a comparison of retention and penetration of preserving oil was made of posts incised while green, incised after air drying, and non-incised controls. Differences between the two incised groups are not significant. Differences between the incised posts and the non-incised posts, however, are significant at the 5 percent level.

3. Based on a minimum preservative retention of 6 pounds per cubic foot and a penetration of 0.7 inch, 4 species or 20 percent in the incised group have marginal treatments. This compares to 17 species or 85 percent in the non-incised group that have non-acceptable treatments.

4. Pino, cadam, and eucalipto are all highly permeable and there is no benefit from incising.

5. Groundline incising together with a short 2 hour - 2 hour hot-and-cold bath schedule appear applicable to the treatment of mixed species of hardwood posts.

6. Cantilever beam tests of low density pino posts show a 25 percent loss in modulus of rupture or bending strength due to incising; hardwoods had about a 15 percent strength reduction.

7. This bending strength reduction is tolerable compared to the benefits gained by the concentration of preservatives at the vulnerable groundline due to incising.

8. Two- or 3-inch diameter incised posts are at least twice as strong in bending as 2.5 mm. gage "U" steel posts commonly used in fencing.

Table 1.--Number of days required to dry incised and non-incised posts to a moisture content of 25 percent

Species	Initial Moisture Content	Drying time	
		Incised	Non-incised
	Pct.	Days	Days
Cacao motillo	51	26	20
Caimitillo	41	22	22
Caoba	37	22	24
Casuarina	34	17	16
Eucalipto	115	54	42
Guaba	45	35	30
Guamá	56	58	76
Hoja menuda	69	46	46
Mangle blanco	58	34	28
Mangle prieto	43	54	64
María	58	35	28
Moca	78	30	18
Péndula	36	14	14
Pomarrosa	78	46	40
Rabo de ratón	73	52	46
Roble blanco	49	28	35
Teca	65	38	34
Uvilla	53	36	28
Average		36	34

Table 2.--Preservative retention and penetration of incised and non-incised posts

Species[1/]	Incised green			Incised dry			Non-incised		
	Retention	Penetration[2/]		Retention	Penetration		Retention	Penetration	
	Lb.per cu.ft.	In.	Pct.	Lb.per cu.ft.	In.	Pct.	Lb.per cu.ft	In.	Pct.
Pino	33.0	1.6	100	35.2	1.5	100	36.0	1.5	100
Cadam	30.3	2.0	100	29.8	1.8	100	25.7	1.3	84
Eucalipto	12.7	1.0	76	16.0	.8	61	9.0	.8	66
Teca	4.6	.5	65	4.2	.6	61	2.1	.4	35
Caoba	6.4	.6	56	5.8	.5	46	1.5	.2	14
María	10.9	1.0	73	11.0	.9	66	4.2	.5	37
Cacao motillo	12.0	1.1	84	11.2	1.1	92	5.3	.6	47
Mangle blanco	4.6	.7	53	5.1	.7	53	2.8	.2	16
Roble blanco	9.9	.8	64	10.2	.9	74	1.9	.2	17
Moca	7.4	.9	74	5.7	.6	50	2.8	.2	17
Guaba	9.7	.7	49	9.3	.8	55	4.1	.3	25
Rabo de ratón	11.1	1.1	92	9.5	1.2	85	5.6	.3	29
Hoja menuda	6.3	.8	46	5.8	.7	45	1.8	.3	17
Guamá	7.7	.8	63	6.3	.9	70	3.1	.2	12
Pomarrosa	7.5	.8	63	6.3	.8	64	1.7	.2	15
Casuarina	7.9	.7	66	8.5	.8	76	2.8	.3	23
Caimitillo	12.4	1.1	82	11.7	1.0	62	4.9	.4	28
Péndula	5.8	.7	51	5.8	.7	50	.9	.1	9
Mangle prieto	6.1	.8	53	6.9	.7	51	2.6	.3	21
Uvilla	4.5	.6	49	4.5	.7	63	1.6	.1	10
Average	10.5	.9	68	10.4	.9	66	6.0	.4	31

1/ Listed in order of increasing specific gravity.
2/ Average penetration of sapwood radius.

Table 3.--Modulus of rupture of incised and non-incised pino (Pinus caribaea) posts

Non-incised			Incised		
Moisture content	Specific[1/] gravity	Modulus of rupture	Moisture content	Specific[1/] gravity	Modulus of rupture
Pct.		P.s.i.	Pct.		P.s.i.
21.3	.41	7900	18.0	.31	3280
19.7	.29	4400	17.6	.40	6040
19.0	.37	6300	19.6	.35	3130
19.6	.38	6770	20.2	.36	5030
18.7	.36	5500	19.1	.40	6900
20.6	.30	3920	19.6	.31	2760
18.6	.38	6790	18.7	.38	5550
19.1	.36	5050	18.4	.32	4330
18.7	.30	4290	18.5	.37	4200
18.4	.37	5330	18.7	.36	2030
Average 19.4	.35	5615	18.8	.36	4330

1/ Based on oven-dry weight and volume

Table 4.--Modulus of rupture of incised and non-incised mixed hardwood posts

Species	Non-incised			Incised		
	Moisture content	Specific gravity 1/	Modulus of rupture	Moisture content	Specific gravity 1/	Modulus of rupture
	Pct.		P.s.i.	Pct.		P.s.i.
Cacao motillo	26.1	.88	15,800	23.6	.84	19,100
Caimitillo	23.3	.84	13,100	20.6	.88	16,600
Caoba	24.4	.48	8,300	30.0	.53	6,500
Casuarina	24.9	.65	12,400	26.2	.69	11,700
Eucalipto	20.5	.57	12,300	20.5	.47	7,700
Guaba	25.3	.65	16,200	26.8	.68	9,820
Guamá	35.2	.68	13,500	32.3	.72	14,600
Hoja menuda	27.2	.78	15,500	27.1	.78	12,700
Mangle blanco	26.3	.57	8,870	23.5	.67	10,000
Mangle prieto	33.9	.92	11,200	34.5	.83	8,350
Moca	23.3	.71	12,100	23.8	.68	10,800
Péndula	23.2	.82	20,500	23.0	.79	10,700
Rabo de ratón	24.4	.72	13,300	30.7	.74	12,200
Roble blanco	28.7	.61	13,900	31.5	.62	10,800
Teca	20.9	.63	15,400	18.3	.59	14,400
Uvilla	27.6	.95	14,900	34.6	.82	10,400
Average	26.8	.72	13,500	26.7	.71	11,650

1/ Based on oven-dry weight and volume.

Table 5.--Modulus of rupture of incised and non-incised casuarina (Casuarina equisetifolia) posts

Non-incised			Incised		
Moisture content	Specific gravity 1/	Modulus of rupture	Moisture content	Specific gravity 1/	Modulus of rupture
Pct.		P.s.i.	Pct.		P.s.i.
27.2	.86	17,800	25.3	.97	15,500
21.3	.97	17,000	26.1	.83	14,700
28.9	.75	17,400	21.1	.84	14,100
32.1	1.01	16,500	26.1	.93	16,800
21.4	.69	13,300	27.8	.75	10,900
26.7	.97	18,900	28.3	.79	13,700
33.1	.75	10,600	25.9	.90	17,100
28.9	.82	15,700	19.9	.97	16,900
26.7	.75	13,000	25.7	.91	8,200
21.4	.79	15,500	31.2	.96	13,600
Average 26.8	.84	15,570	25.7	.88	14,150

1/ Based on oven-dry weight and volume.

LITERATURE CITED

(1) American Wood Preservers' Association
1952. Survey of incising practices. Rpt. Committee T-1. Proc. Amer. Wood Pres. Assoc. 48:217-220.

(2) _____
1962. Manual of recommended practices. Amer. Wood Pres. Assoc., Wash., D. C.

(3) Blew, J. O. and Kulp, J. W.
1964. Service records on treated and untreated posts. U. S. Forest Serv. Forest Prod. Lab. Rpt. FPL-068.

(4) Bryant, B. S.
1953. The effect of incising on the bending strength of crossarms. Forest Prod. Jour. 3(2):47-48.

(5) Chudnoff, M.
1967. Post incising machine design. Forest Prod. Jour. 17:33-34.

(6) _____, Boone, R. S., and Goytía, E.
1967. Preservative treatments and service life of fence posts in Puerto Rico. U. S. Forest Serv. Inst. Trop. Forestry Res. Paper ITF-4.

(7) Englerth, G. H., and Goytía Olmedo, E.
1960. Preservation of Puerto Rican fence posts treated by cold soaking and the hot-and-cold bath method. U. S. Forest Serv. Trop. Forest Notes No.2.

(8) Forest Products Laboratory
1944. Design of wood aircraft structures. ANC Bul. 18 Army - Navy - Civil Comm. on Aircraft Design Criteria, Aero. Board, Wash., D. C.

(9) Graham, R. D.
1951. Round timber peeling and incising machine. Chemurgic Digest 11(6).

(10) _____, and Miller, D. J.
1964. Service life of treated and untreated fence posts. Progress Rpt. No.12, Oreg. State Univ., Forest Res. Lab., Corvallis.

(11) _____
1966. Preservation of wood for home and farm. Rpt. P-7, Oreg. State Univ., Forest Res. Lab., Corvallis.

(12) Harkom, J. F.
1932. Experimental treatment of hardwood ties. Proc. Amer. Wood Pres. Assoc. 28:269-282.

(13) Walters, C. S., and Peterson, K. R.
1963. Preservative treatment of fence posts by cold soaking in pentachlorophenol-fuel oil solutions. Forestry Note No.103, Univ. of Ill., Dept. of Forestry, Urbana.

Chudnoff, M., and Goytía, E.
1967. The effect of incising on drying, treatability, and bending strength of posts. Inst. Trop. Forestry, U.S. Forest Serv. Res. Paper ITF-5.

A commercially feasible post incising machine is described and was used to prepare test material to determine the effect of incisions on: 1) air drying time, 2) preservative absorption and penetration, and 3) bending strength of small diameter posts. Incising had no significant effect on air drying time but resulted in significant improvement in the treatability of the 20 species evaluated. Incising does result in a 15 to 25 percent reduction in bending strength but this loss is tolerable compared to benefits gained by preservative enrichment of the vulnerable groundline.

Chudnoff, M., and Goytía, E.
1967. The effect of incising on drying, treatability, and bending strength of posts. Inst. Trop. Forestry, U.S. Forest Serv. Res. Paper ITF-5.

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